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Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) – Annex 46

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Overview methodology for the use of simulation tools to support screening of energy conservation measures in IEA Annex 46

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The team….
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<u>Subtask B</u>: Develop a database of "Energy Saving Technologies and Measures for Government Building Retrofits" with examples of best practices

What we are going to do –

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- **Create a virtual world with building sites located all around this world.**
- **Each of these virtual building sites includes a mix of ubiquitous buildings such as offices, barracks and workshops.**
- **This virtual place has a few off-limits buildings which never change (our reference cases).**
- **Everything else has teams of *clever folk* going around making refurbishment 'improvements'. The virtual dust they create settles quickly and they are followed by other teams who record what happens next. In our virtual world, seasons pass quickly.**
- **And we, the team, observe the virtual world and try to pick out which of the 'improvements' worked, and which just created expensive dust.**

Virtual worlds have limitations:

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- ***The team*** **can only oversee a few building sites (so we much be careful where we pick them).**
- **Each cities virtual building site can have a *few* different rules (façade details, set points, working hours, environmental systems, etc.) But not that many.**
- **The virtual buildings have to be designed so that they can be refurbished with many different energy conservation measures.**
- **The virtual world might not have a way to implement every energy conservation measure.**
- **We need to measure enough about the performance of our buildings so that the unintended consequences of the improvements get noticed (but without filling the disk).**
- **And we, the creators of this virtual world, have to plan it well enough that we don't have to nuke it and start over again.**

A methodology to:

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- **select building types which have wide application and retrofit options which are applicable to a range of budgets and goals.**
- **identify promising energy saving measures (ECM) for each building type.**
- **ensure the physics of each ECM are well represented**
- **derive representative base-case performance**
- **create model variants for ECMs.**
- **analyze the matrix of ECMs, climatic conditions, energy costs**
- **hold the matrix of predictions in a form so that others can use it to be *really* clever and not create expensive *real* dust.**

Select building types which have wide application and which are likely to be subject to retrofit

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The initial list is:

- **An office building**
- **A barracks/dormitory**
- **A mixed use industrial building**

Industrial Building Model Assumptions

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- 4650 m2 (50,000 ft2)
- 10% Office space
- 10% Shipping and Receiving
- 20% “Thermally Intensive” Processing Area
- 20% “Ventilation Intensive” Processing Area
- 40% “Light fabrication” Processing Area

Industrial Building Model Assumptions

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- 150mm, (6”) concrete walls (pre-cast) for exterior & insulated metal walls internally
- 50mm (2”) ‘built-up’ roof
- Uninsulated slab floor
- 10% glazing in process area
- 25% glazing in office area
- Four large 12’ x 15’ doors in shipping area

Industrial Building Model

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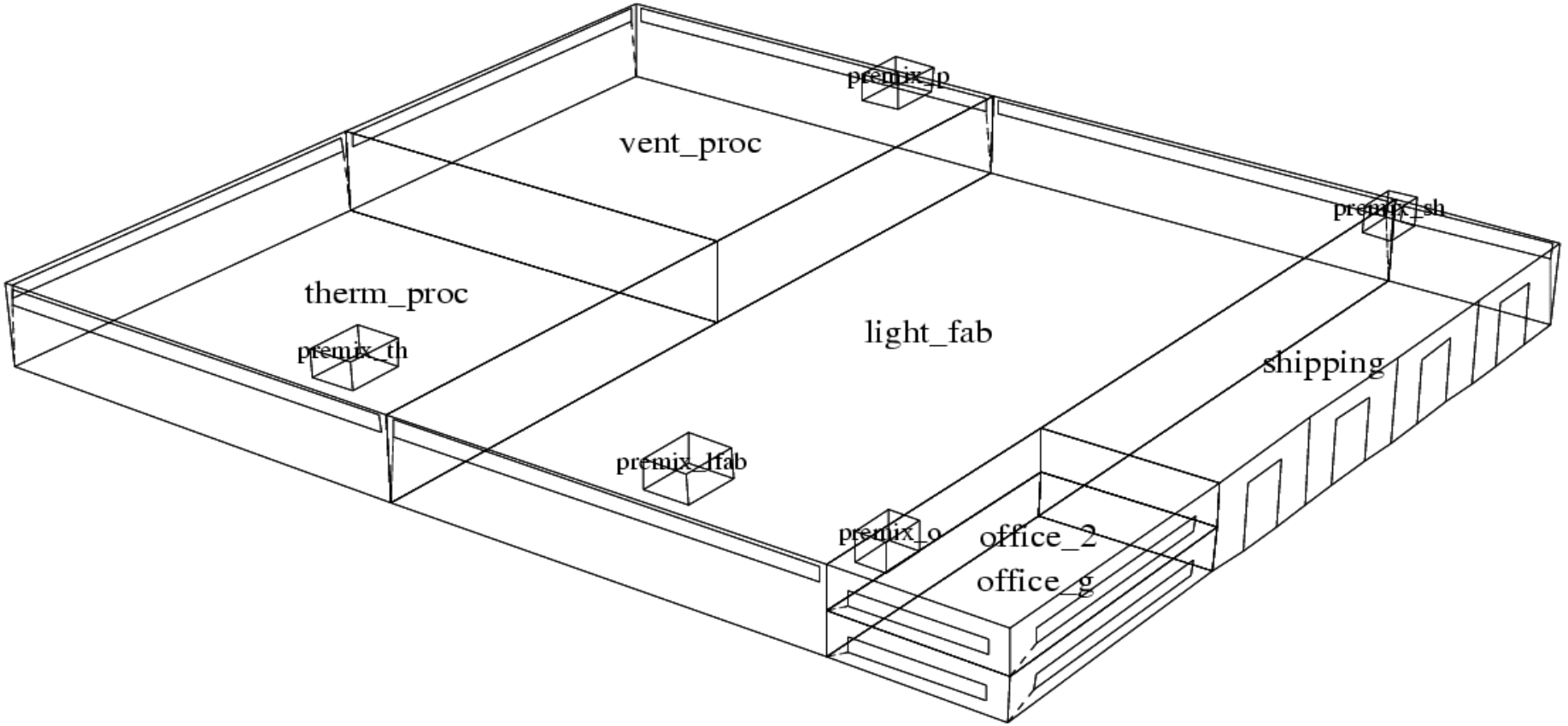

Project: The industrial base case model

Industrial Building Model

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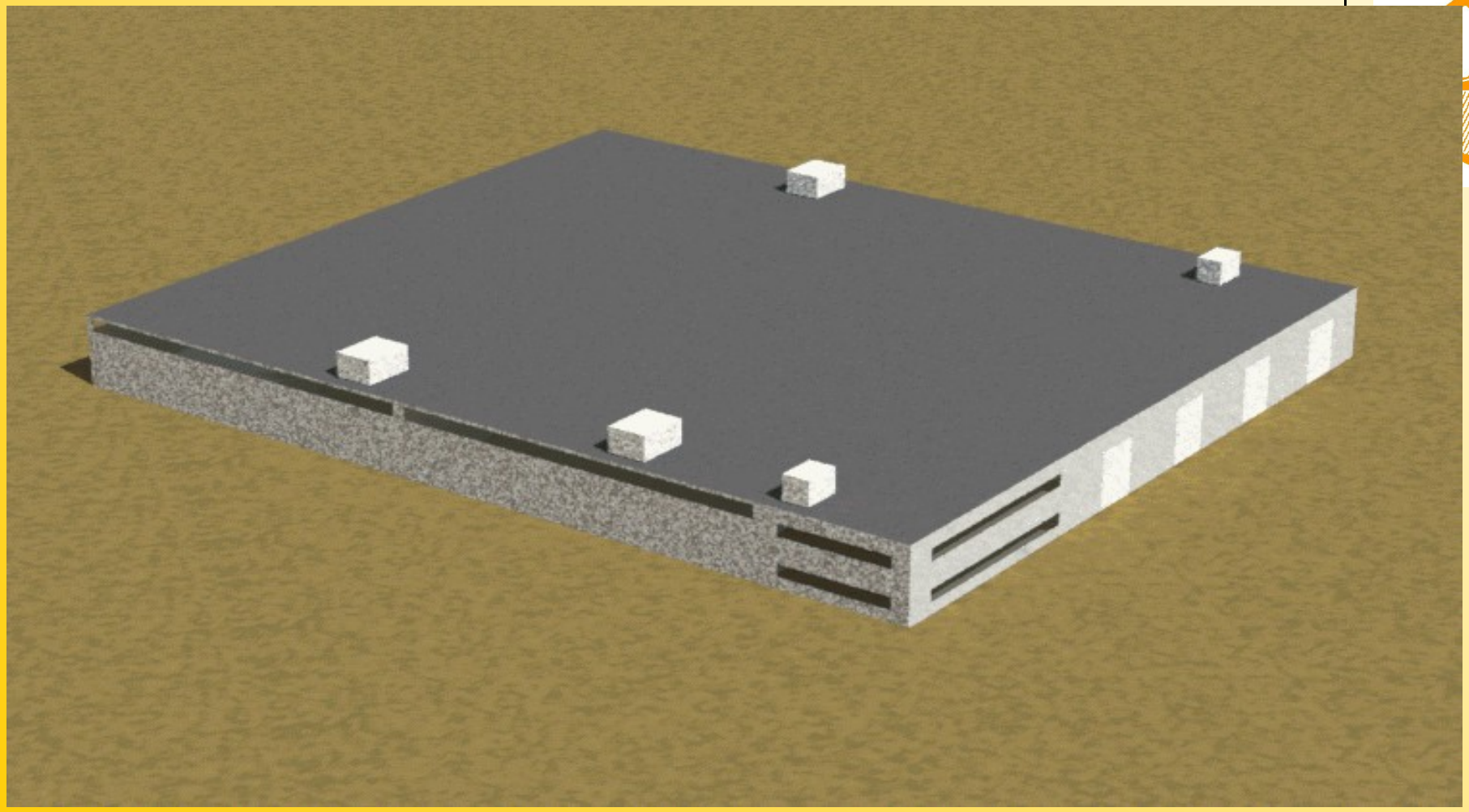

Office Building Model Assumptions

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- 2160 m2 23,250 ft.2
- 4 floors
- 18 zones
- 1 Utility/common core area per floor
- 2 Office areas per floor
- Supply and return plenums to facilitate ventilation studies

Office Building Model Assumptions

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- Façade is a mix of brick and an exterior insulation finish system (EIFS)
- ~30% glazing
- 150mm (6 inch) uninsulated slab floor
- 100mm (4 inch) concrete floors

Office Building Model: Ground & Mid-Floors

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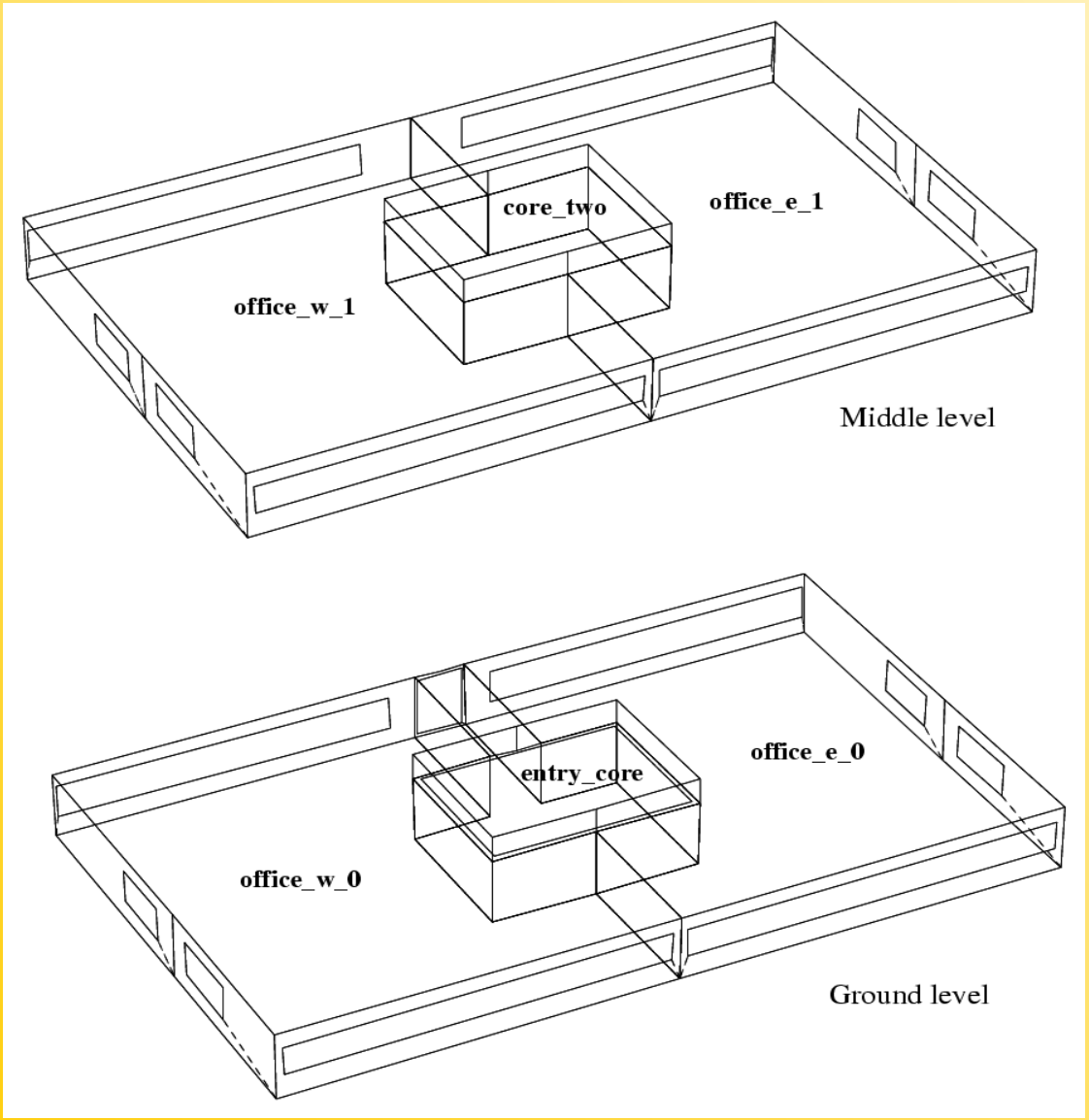

Office Building Model

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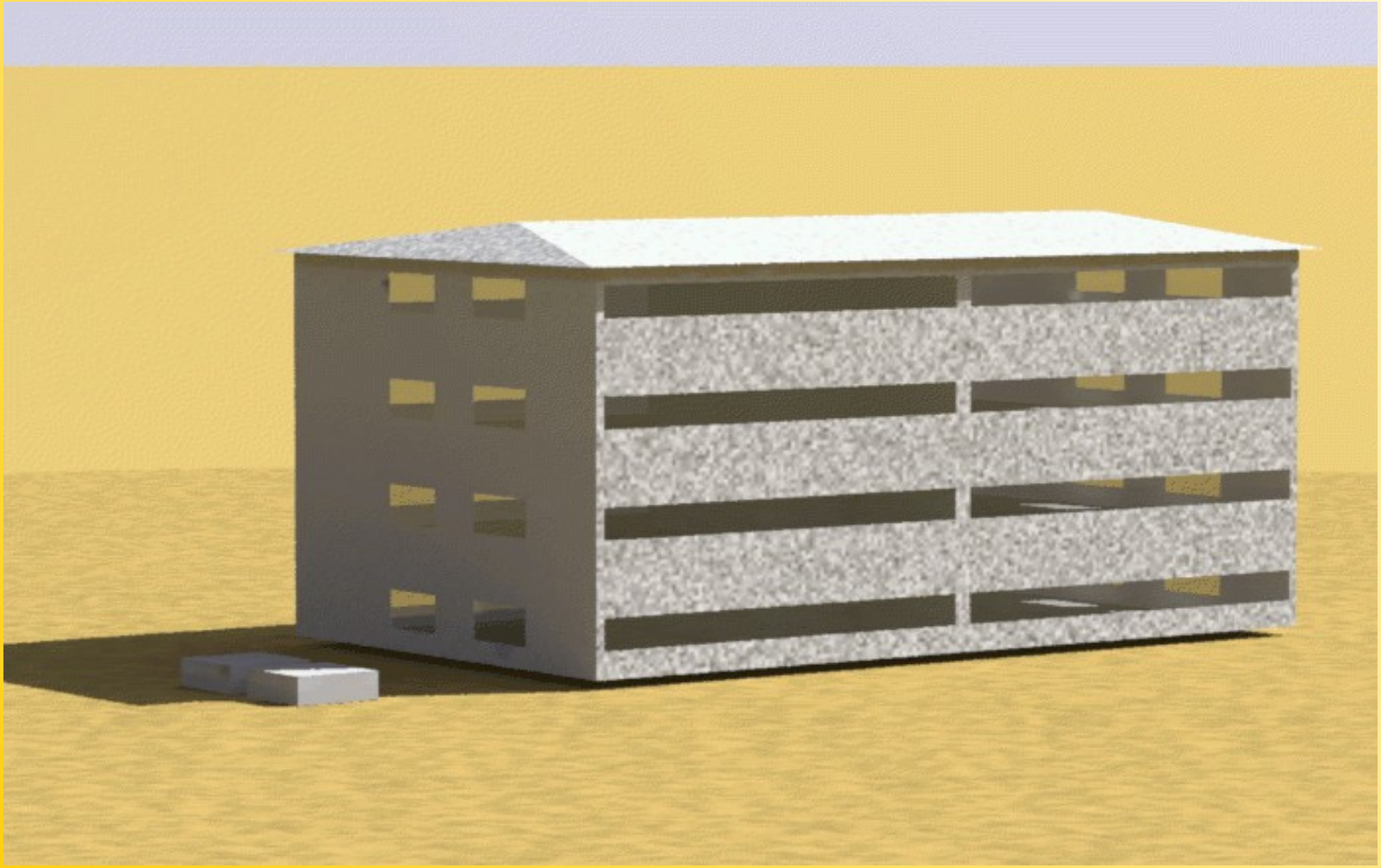

Barracks/Dormitory Building Model Assumptions

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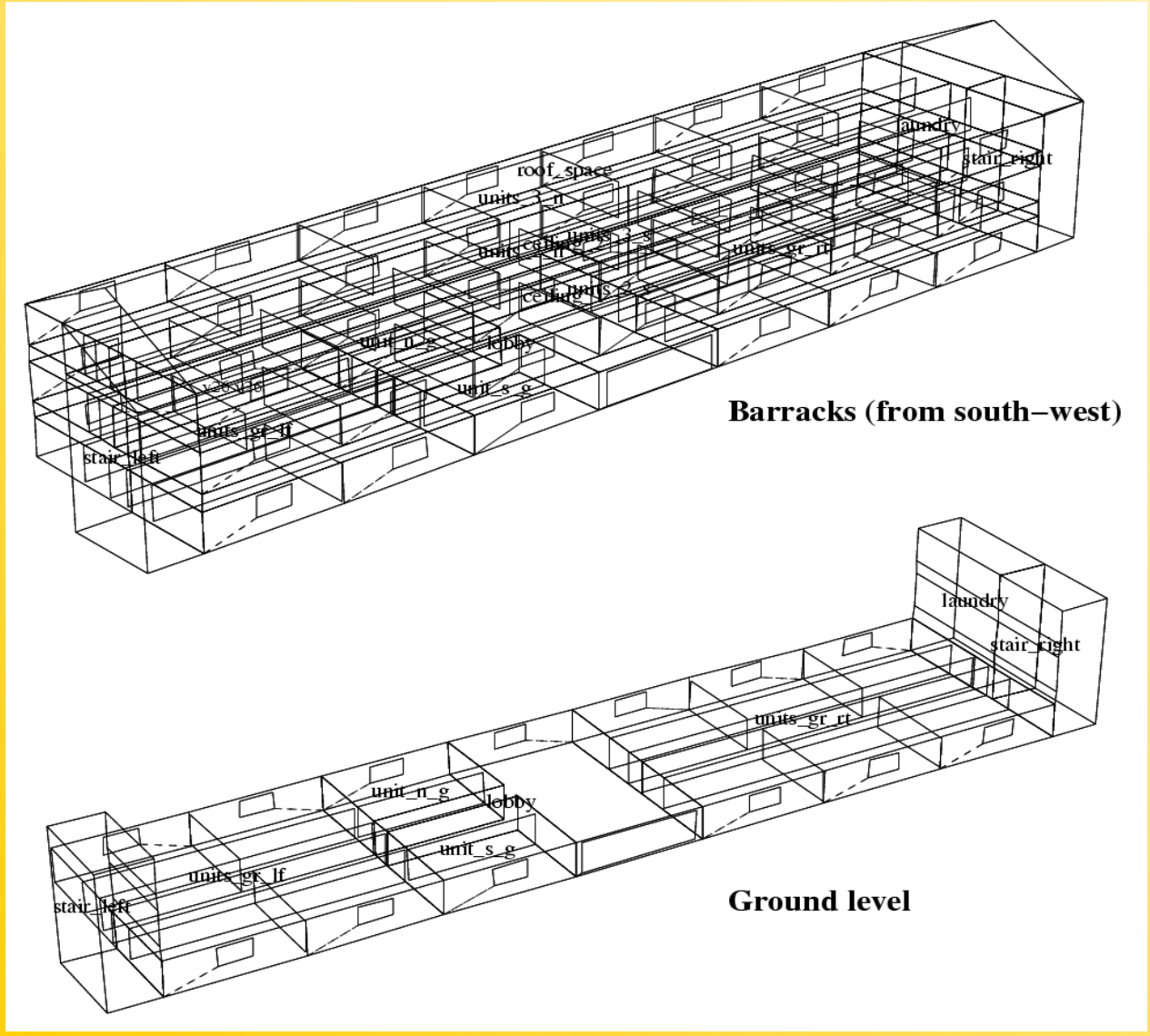
- 2709m2, 29,150 ft2
- 3 floors
- 15 zones
- 1 laundry area per floor
- Stairwell at each end of building
- Ground floor lobby
- Supply and return plenums to facilitate ventilation studies

Barracks Model



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Barracks Model

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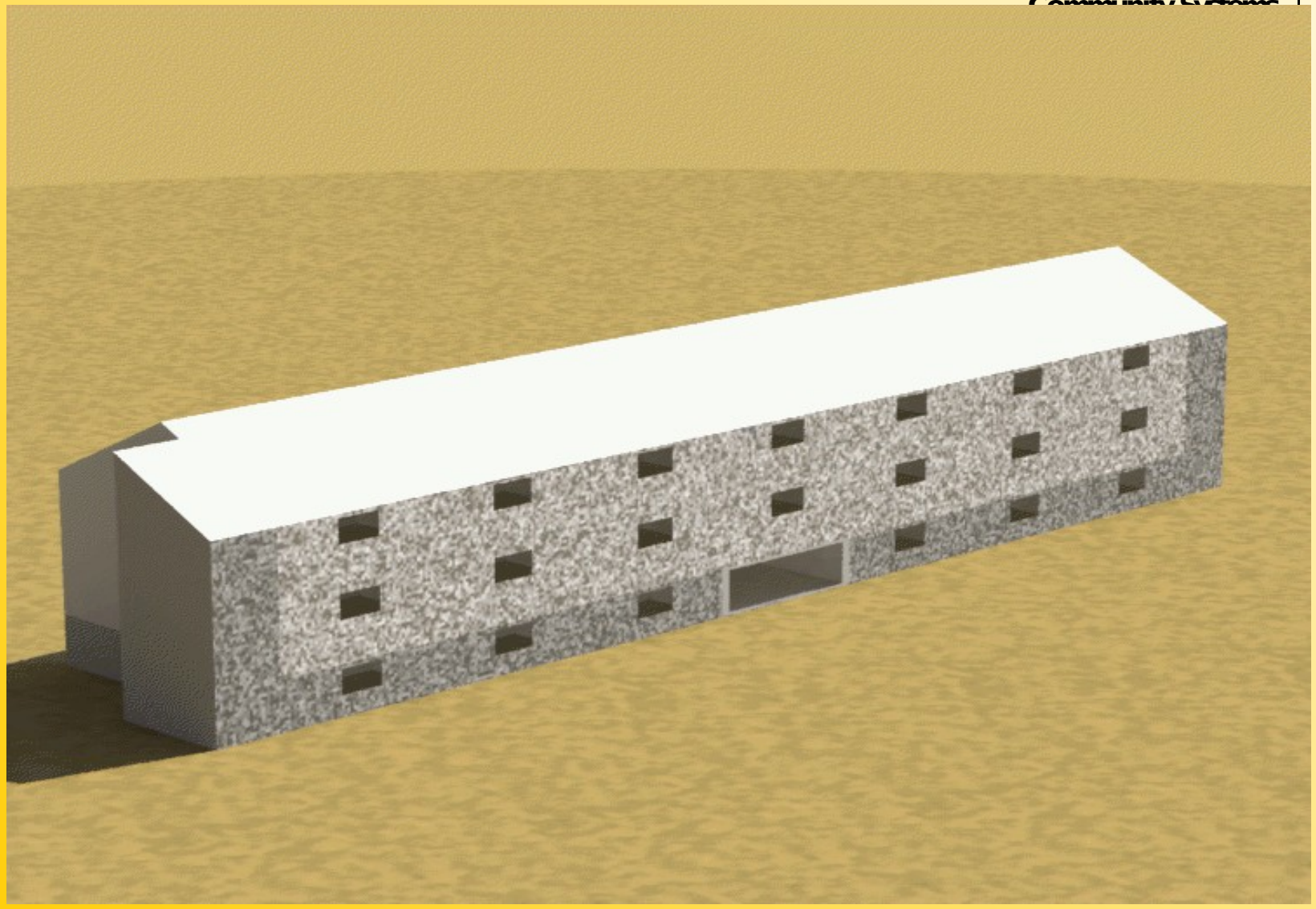

Develop list of promising energy saving measures (ECM) for each building type

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- Some ECM will be applied to all building types.
- Some ECM only make sense in particular cities.
- Some ECM only make sense to a particular building type.
- Some ECM only make sense in particular room types.

Methodology – each ECM is assessed in isolation and only compared against the base case.

Wish-list of ECMs for Dormitory and Office Buildings

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Façade refurbishment:

- Install high performance windows.
- Install operable windows.
- Implement hybrid ventilation scheme.
- Upgrade doors (better insulation and seals).
- Construct Solar walls.
- Install vestibules at entrances.
- Install vertical fins on exterior wall

Roof refurbishment:

- Implement “Cool roof” technology.
- Insulate roofs to a higher standard.

More for Dormitory & Office Buildings

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Site modifications

- Install windbreaks near buildings.
- Plant trees (shade)

Interior refurbishment

- Install ‘light tubes’
- Install light shelves.
- Implement day lighting controls
- Install T8 bulbs and instant start ballasts.
- Add task lighting.

Ventilation refurbishment

- Implement night pre-cooling scheme
- Install separate ventilation AC systems
- Reduce duct leakage
- Insulate supply and return ducts
- Insulate hot/cold water pipes
- Install demand control CO_2 sensors.

ECMs for Dormitory and Office Buildings

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System refurbishment:

- **Replace window AC with central air system.**
- **Replace window AC with DX split system**
- **Install enthalpy wheels (heat recovery).**
- **Install direct evaporative coolers.**
- **Install indirect evaporative coolers.**
- **Install hydronic heating/cooling panels.**
- **Install hydronic heating convectors.**
- **Install occupancy sensors.**
- **Use floor heating instead of convective heating.**
- **Install thermal energy ice storage.**
- **…..**

ECMs for Industrial Buildings

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- Install skylights for natural lighting.
- Install displacement ventilation system.
- Install de-stratification fans.
- Implement outside air economizer cycles.
- Replace convective with radiant heaters.
- Install evaporative coolers
- Install high efficiency exhaust hoods.
- Construct Solar walls for ventilation air preheat.
- Apply low emissivity roof coating.
- Install vestibules for large openings.
- Install high-speed roller doors.
- Improve building envelope against air leakage.

ECMs for Industrial Buildings

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- **Balanced HVAC system with exhaust hoods.**
- **Use setback thermostats.**
- **Turn-off equipment when not in use.**
- **Operate AHU system on occupancy schedule.**
- **Install close capture vehicle exhaust system.**
- **Install VFD fans in paint booths air exhaust system.**
- **Implement process ventilation air heat recovery.**
- **…**

Analyze ECMs for different climatic conditions and energy costs

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- The matrix is potentially large
- The team might have created a virtual world, but it is subject to the law of garbage-in gospel-out
- Quality control and quality assurance are a big issue
- Issue – how to notice useful information/patterns within a large matrix.
- The team proposes to release the models ‘to the community’ as a resource and for further study.
- Develop data-base supported by examples of good-practices/show case descriptions

Develop data-base supported by the matrix of assessments

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- **The team will work with other members of the IEA Annex 46 to define a file-store to how performance predictions and information about the design variants.**

Subtask B Milestones

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Milestones

- **Some building types will be fast-tracked**
- **Some ECMs will be given priority so that early indicators will be available to other teams.**
- **Requests for information on ‘regional’ design variants will go out early and be time-limited to ensure deliverables.**
- **Some dependencies vis-à-vis Task D will need to be resolved.**